UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF AGRICULTURAL AND INDUSTRIAL CHEMISTRY

CONFERENCE ON CITRUS PROCESSING

MAY 9, 1951

U. S. CITRUS PRODUCTS STATION
WINTER HAVEN, FLORIDA

F O R E W O R D

In summary form, the following pages present the information exchanged by speakers from industry, federal and state research agencies, and the Quartermaster Corps during a conference on citrus processing, held in Winter Haven, Fla., on May 9, 1951.

The conference was arranged by the Bureau of Agricultural and Industrial Chemistry of the U. S. Department of Agriculture through its field office, the U. S. Citrus Products Station in Winter Haven,1/ in cooperation with the Station's Technical Advisory Committee, the Citrus Products Research Council, the Citrus Experiment Station, the Florida Canners Association, and the Florida section of the Institute of Food Technologists.

With emphasis on the increasing role of processed products in utilizing the nation's citrus crops, the program stressed technological advances achieved during recent years through grower-industry-research cooperation and called attention to major problems now under study. For additional information on any subject covered, contact the author or agency concerned.

1/ Administered by the Southern Regional Research Laboratory in New Orleans.

CONTENTS

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ABSTRACTS OF PAPERS AND DISCUSSIONS

RECOVERY OF ESSENCE FROM FRUITS

by

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Essence, or volatile fruit concentrate, is the fruit aroma in concentrated form. In most fruits, at moderate concentrations, essence is an aqueous solution of the volatile flavors. At high concentrations, the oily components may exceed their solubility in water and the essence is then in two phases, an aqueous and an oil phase.

The Eastern Regional Research Laboratory originally developed a process for the recovery of apple essence. Although various modifications in carrying out the individual steps have been made to adapt the equipment to other fruits, the basic process remains the same. It entails the following operations: (1) vaporize sufficient juice to release the aroma (usually 10-20 percent), doing this quickly enough to prevent heat damage; (2) separate vapor from liquid; (3) concentrate aroma in vapor by fractional distillation; and (4) recover aroma from vent gas. This process is now in general commercial use with apple, grape, and certain other fruit juices.

Later improvements in some of the foregoing steps include:

(1) Preheating and partially vaporizing the juice in separate units. This cuts heat effect to about 1/10 that originally experienced. This very rapid heating strips the aroma, inactivates enzymes, and pasteurizes the juices without heat damage.

(2) Scrubbing vent gases with chilled column bottoms instead of with chilled essence. This permits making higher-fold essences and more effectively recovers very volatile aroma. This method of scrubbing also permits the apparatus to be operated under vacuum (should a heat sensitive juice require it) without significant increase in aroma loss.

Essence recovery from conventional vacuum concentration of fruit juices (at least at moderate vacuum) and in preserve making can be done by condensing the vapors, scrubbing vent gases with water, combining the two liquids and then processing them in the apparatus used for processing the juice itself.

Essences are used to make full-flavor concentrates for reconstituting with water to a "fresh" juice; for example, apple and grape. They can be used to contribute characteristic fruit flavor to candies,

carbonated beverages, and ices, and when consistent with standards of identity, to enhance the flavor of jams and jellies from which they were derived.

Application of essence recovery to citrus juices is now under investigation in the Bureau, but the work has not progressed sufficiently to report findings.

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FLAVOR FORTIFICATION OF CALIFORNIA FROZEN ORANGE CONCENTRATE

by

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The low-temperature, high vacuum evaporation process used to produce concentrated orange juice removes not only water, but also a large proportion of volatile constituents which give the product its characteristic fruity flavor and aroma. To investigate the flavor fortification of California frozen orange concentrates, laboratory and pilot plant studies were conducted to determine what volatile fractions were responsible for the orange flavor and aroma. It was also a part of this study to determine whether any of these volatile fractions could be used to supplement or replace the cut-back juice ordinarily used to restore flavor and aroma to the concentrate. This was done by literally taking the juice apart without heat damage, using the low temperature evaporation process, and putting it back together using various combinations of the fractions obtained. Orange juice was fractionated into three parts: a 55° Brix concentrate; a water condensate possessing some orange aroma, and an oil-water emulsion possessing a strong orange aroma.

Lots of the 55° Brix concentrate were reconstituted to single strength by adding proportionate amounts of the water condensate, but such juices lacked the characteristic orange flavor. However, when the oil-water emulsion was added to similar lots of concentrate, the typical orange flavor and aroma was restored to the reconstituted juices. These results appeared to indicate the orange flavor and aroma was associated primarily with the trapped volatile oil fraction. Further work indicated that the major part of the volatile oil fraction consisted of peel oil, which suggested the possibility of substituting a commercial grade peel oil for the cut-back juice as a means of restoring flavor to concentrates. Under pilot plant conditions,

it was found that volatile flavor and aroma lost during evaporation of concentrates could be restored by using cold-pressed peel oil and orange puree in the place of the cut-back juice. The flavor of concentrates fortified in this manner was found to be stable at 0° F. (-18° C.).

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DISCUSSION

Question: What absorbent did you use?

Answer: Lithium bromide and chloride and other hygroscopic salt solutions similar to those used in dehydrating gases or in air conditioning. The oil collects on the surface and can be returned to the product.

Question: Have you tried solvent extraction for cold pressed oil?

Answer: No.

Question: Is cold pressed oil as good an additive as oil from the trap or sac oil?

Answer: Yes. But one must select a good grade cold pressed oil.

Question: Is peel oil stable in concentrate?

Answer: Yes. Samples have been kept up to 9 months at zero.

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GELATION AND CLARIFICATION IN CITRUS CONCENTRATE

by
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Data secured during the 1948-49, 1949-50, and 1950-51 seasons by cooperative research of the Florida Citrus Experiment Station and the Florida Citrus Commission provide the basis for a discussion of basic and practical factors related to the gelation and clarification of concentrated citrus juices.

Frozen citrus concentrate contains pectin and pectic enzymes. When these products are stored at temperatures above 0° F., the pectin is converted into low-methoxyl pectin by pectinesterase. The low-methoxyl pectin thus formed combines with calcium present in the

concentrate to form low-methoxyl pectin gel. The pH range found in citrus concentrates is ideal for gel formation.

Practical factors involved are fruit variety, quantity and type of pulp, and proper storage temperature. Seedy varieties of fruit, such as Pineapple oranges, yield concentrate that is more susceptible to clarification and gelation than that made from less seedy varieties, such as Valencia oranges. The quantity and type of pulp present in concentrate are important, since pectin and pectic enzymes are present in the cellular and insoluble portions of pulp. Gelation and clarification definitely increase as the amount of pulp in the concentrate is increased. Gelation and clarification do not occur in frozen citrus concentrates when these products are stored at the recommended temperatures of 0° F. or below, since enzyme changes are retarded at low temperatures.

Possible methods for the prevention of gelation and clarification are (1) modification of processing procedures to eliminate excessive amounts of pectin and pectic enzymes in the finished product, (2) storage at all times at temperatures of 0° F. or below, (3) heat treatment of juice prior to evaporation or pasteurization of the finished concentrate to inactivate the pectic enzymes, and (4) the addition of chelating agents and surface active enzyme inhibitors.

* * *

DISCUSSION

Question: What was the duration of heat treatment given the products to which you made reference?

Answer: The juice was heated to noted temperature in 3 seconds, and immediately flashed into the evaporator.

Question: What is the effect of polyvalent ions?

Answer: Calcium or other polyvalent ions are necessary for the formation of a low-methoxyl pectin gel. Quantitative determinations of the calcium content of concentrated citrus juices have not been made.

Question: At what temperature of pasteurization was flavor change apparent?

Answer: Taste panel findings indicate detectable flavor change when heated at 150° to 155° F. It has yet to be proven that any heat treatment will give a product as good as current frozen concentrate.

Question: In testing for gelation, what was the temperature of storage?

Answer: The concentrate is removed from frozen storage (0° F. or below) and stored immediately at 80° F. for 24 hours. Similar results are obtained if the concentrate is stored at 40° F. for 7 days; however, results are obtained much faster if the 80° F. storage is used.

Question: What method was used for determining enzyme activity?

Answer: A method applying information previously published by Kertesz, Lineweaver, Jansen and others.

Question: Do you encounter gelation with Valencia oranges?

Answer: Valencia concentrate is not as susceptible to gelation as concentrate made from Pineapple oranges, which are a seedy variety. Valencia concentrate will clarify and low grade gels have been encountered experimentally. With this variety there was no correlation between extractor pressures and the degree of gelation in the concentrates made from one lot of fruit, using four different extractor pressures.

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PROCESSING HEAT-SENSITIVE LIQUIDS BY STEAM INJECTION

by
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A direct steam-injection heater has proved useful in the high-temperature, short-time processing of fluid foods, including purees as well as liquids. Fluid foods can be heated to 300° F. in 0.5 second or less at practical processing rates. Pasteurization, sterilization, enzyme inactivation and/or deodorization are among the results achieved with the injection heater on fruit juices and fruit and vegetable purees. Improvement in concentration or essence-recovery operations is obtained by use of the injection heater to superheat fluid entering a single-tube, steam-jacketed vaporizer.

A characteristic of the equipment is high resistance to fouling. The injection heater has no heat-transfer surfaces to foul. Lack of fouling in the vaporizer tube, even at high jacket temperatures, is attributed to the fact that the injection heater provides high fluid velocities over the entire heat-transfer surface. Overall heat transfer coefficients in the vaporizer tube (1/2-inch IPS stainless steel pipe, steam-jacketed over 6 feet of its length) range from 510 to 500 BTU/hr.-sq.ft.-° F. (based on inside area of tube) with water, apple

juice, milk, and berry puree. The product side heat transfer coefficients in the vaporizer tube range from about 1100 BTU/hr.-sq.ft.-°F. with berry-sucrose purees containing more than 30 percent solids, to about 1300 BTU/hr.sq.ft.-° F. with pulpy apple juice. The overall coefficient decreased only 1 percent per hour during a 12-hour period of continuous operation on cloudy juice from Delicious apples, and only 5 percent during 60 hours of operation on apple juice without cleaning other than operation of the system on water for 20-minute periods at intervals of about 8 hours.

Materials processed in the system to date include juices (grape, tomato, orange, five varieties of apple, and pulpy apple juice, the commercial product made by grinding apples through a very fine screen), milk, and purees (apricot, pea, peach, pear, and berry, the last a blend of raspberries, youngberries, and sucrose). Product evaluation tests indicate that the high-temperature, short-time, heat treatments employed are effective in pasteurizing and inactivating enzymes in fruit and vegetable products with a minimum of flavor alteration.

* * *

DISCUSSION

Question: How do the liquid-side heat transfer coefficients obtained in the vaporizer tube compare with the theoretical values or values reported in the literature?

Answer: The coefficients obtained with water, 1300 to 1600 BTU/hr.-sq. ft.-° F., are in the same range as those reported by McAdams for boiling of water in tubes.

Question: What velocity does the fluid attain in the vaporizer tube?

Answer: The fluid (mixture of vapor and liquid) enters the tube at a velocity of about 20 ft./sec. and leaves at about 200 ft./sec.

Question: How much steam is consumed in the steam injection heater?

Answer: The amount of steam consumed depends on how much the feed is heated. Roughly, 0.1 lb. of steam is consumed in heating 1 lb. of feed 100° F.

Question: What is the purpose of the preheater?

Answer: The preheater portion of the combination evaporator is necessary to provide a mixture of liquid and vapor to feed to the vaporizer tube.

Question: Can fruit juices withstand short-time heating to high temperatures without developing off flavors?

Answer: With fruit juices other than orange, we have not found perceptible flavor change resulting from heating the juices to 250° F. for a few tenths of a second.

* * *

STORAGE OF FROZEN CITRUS CONCENTRATE

by
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Commercial frozen citrus concentrates of orange juice, grapefruit juice, tangerine juice and blended orange and grapefruit juices were stored at -20, -8, 0, 5, 10, 15, 20, 25, 45, and 75° F. Samples were examined periodically. The microorganism count decreased rapidly at all temperatures of storage below 25° F. Corrosion of the cans correlated with storage temperature. No etching of the tin plate was observed at 0° F. or lower storage temperature up to 330 days. Viscosity changes measured were erratic. Off flavor developed gradually at the higher storage temperatures.

At each storage temperature a taste panel did not detect off flavor development until changes in appearance were well advanced. Vitamin C was remarkably stable even at the higher temperatures of storage. Gelation was not observed in any of the samples, nor did the concentrate show any separation or coagulation of the pulp when defrosted at the end of ten months at a storage temperature of 0° F. or below. At higher storage temperatures coagulation of pulp was noticeable. The cloud retention of the reconstituted concentrate was found to be a sensitive measure of degradation in unheated concentrates.

Storage temperatures greatly affect the rate of chemical and physical change in stored concentrates.

* * *

DISCUSSION

Question: How were samples prepared for viscosity tests?

Answer: Samples of concentrate were heated to 190° F. to inactivate the enzymes, followed by cooling to 75° F. They were then centrifuged for 10 minutes at 2000 R.P.M. and then decanted and strained through 50 mesh bolting cloth to remove floating cell walls. Sample was then adjusted to 42°. Measurements were made in centipoises using the Hoeppler falling ball viscosimeter.

Question: What variety was used?

Answer: The concentrates used in this study were produced in mid-season 1949-50. The varieties were mostly pineapple, seedling and a few early Valencia oranges.

Question: What percentage of pulp was in the juice?

Answer: The concentrate contained 10 percent pulp measured by the centrifuge tests.

* * *

PASTEURIZATION STUDIES

by
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Experimental packs of orange and grapefruit juice were prepared using heating time of 1.75, 13, and 35 seconds over a range from 140 to 280° F. Holding, cooling, filling, can closing, and can cooling times similar to those attainable in actual cannery practice were used. With temperatures of 140 and 150° F. yeast fermentation, and swelling of the cans were encountered. No swollen cans were found when temperatures of 160° F. or above were used. Weak phosphatase and peroxidase tests were obtained in fresh juice, but in juices heated to 160° F. or above negative tests were obtained.

Several methods of testing for pectin esterase (pectase) and clarification were tried.

Viscosity measurements indicated a slight decrease at or near the enzyme inactivation temperature after storage for six months. Considerable clarification was observed in samples packed in glass bottles regardless of the pasteurization temperature, but in a majority of cases the cloud was retained as soon as the enzymes had been inactivated. The change was usually quite gradual with changes in pasteurization temperature. Difficulties were encountered in applying Loeffler's "cloud index" test and better agreement was obtained by shaking the sample uniformly and then making the determination. A new test for residual pectin esterase activity was devised (see Proceedings 1950 of the Fla. State Hort. Soc.) that is quite rapid and gave good results.

With 1.75 seconds heating time, enzyme inactivation was reached at 200° F. except in one case with a low acid juice where 210° F. was required. With 13 seconds heating, 195° F. was sufficient, and with 35 seconds heating, 190° F. resulted in negative enzyme tests. With lower pH values, lower temperatures were sufficient for pectin esterase inactivation.

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DISCUSSION

Question: Was there much difference between high and low processed juices?

Answer: Not much; could tell no difference on grapefruit. Low speed was favored for orange juice.

Question: What attention was given to cooling the filled cans and what effect did this have on flavor?

Answer: No attempt was made to study the effect of cooling. All cans were cooled to 90° F. or lower.

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SOME EFFECTS OF FREEZES OF THE PAST SEASON IN THE RIO GRANDE VALLEY

by
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Minimum temperatures in the Lower Rio Grande Valley in the past have been lower than during the freezes of 1950-51, as for example 12° F. in 1899. The recent freezes, however, complemented each other, and together resulted in the greatest disaster the Texas citrus industry has ever known.

Final analysis of damage from these freezes cannot be made until some months after growing conditions again become favorable. The period of drouth beginning October 5, 1950, had not ended on May 1, so conditions for tree recovery have been extremely unfavorable.

In January 1949, the citrus tree population of the Valley was between 13 and 14 million. On April 1, 1951, it was generally estimated that 5 million trees were in good enough condition to eventually become commercially profitable. Because of continued drouth, by May 1 the estimate had been reduced to 4 million trees, and will be continually, but more slowly, revised downward during the duration of the drouth.

Soon after the freeze, production estimates for 1951-52 were as high as 5 million boxes, but these have been gradually reduced to a half-million boxes. Recovery of trees will probably see production increase slowly for several years to 5 million boxes three years from

now. Replanting is definitely planned by larger growers, but the industry in general has shown no desire to replant hurriedly.

Seriously damaged fruit has been successfully salvaged by processing for single strength juice. Processing must take place before active fermentation begins, and high pasteurization temperatures must be used. Juice from damaged fruit is characterized by a more chalky appearance, lower acid content, slightly more bitterness, and a definitely more mature flavor.

Reporting on our work with frozen concentrates under this subject is logical, as it has all been done with fruit influenced in some manner by freezing weather. In February and March, 1950, fruit produced on sucker growth from trunks and heavy branches yielded juice of good quality. Sufficient progress was made to warrant the following observations:

(1) Texas grapefruit will make excellent concentrate without sweetening.

(2) Texas grapefruit concentrate, 1950 crop, would not gel, but would lose cloud under adverse conditions.

(3) Concentrate from red grapefruit holds an attractive pink color in storage, and is less bitter than concentrates from white fruit.

(4) Minimum concentration and fortification of flavor with peel-oil and essence will probably prove superior to over-concentrating and cutting back with fresh juice.

During the 1950-51 season, the above observations, in general, were corroborated. However, only freeze-damage fruit was available, and this did not produce concentrates of satisfactory flavor.

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ARMY NEEDS IN THE CITRUS FRUIT FIELD

by
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The Food Service Division of the Office of the Quartermaster General of the Army plans a year in advance the menus which are used as a guide to subsist troops located in the Continental United States. It also prepares menus utilizing entirely nonperishable foods. These are designed for use in areas where no refrigeration is available,or to which the transportation of perishable foods would be impractical. Some items are bought locally by stations, but the bulk are procured through the Army's Market Center System for perishables, and Central Procurement Offices for non-perishables.

A general policy in all menu planning is to provide those foods to which the soldier was accustomed before his entry into the service. While the principal objective is to make the diet acceptable, planning does not overlook nutritional requirements.

The Army's menus contain generous quantities of citrus juices, both in the canned and frozen concentrated states. In the last few years there has been a noticeable increase in this use. Some of this increase is due to the high acceptability of frozen concentrated orange juice. As specifications for other frozen concentrated citrus juices become available, it is believed that further increased use of these items will be made. The Army is still seeking a concentrated citrus juice that has the stability and acceptability of the single strength juices. The reason for this is obvious. Such an item would save considerable weight and space when transported to overseas area.

* * *

DISCUSSION

Question: What quantity of citrus juices is considered a serving?

Answer: Orange juice--12 No. 3 cylinders per 100; frozen orange concentrate--4 32-oz. cans per 100; and the same for orange ade prepared from frozen orange concentrate.

Question: Is the Army interested in dehydrated orange juice?

Answer: We are always interested in any possible reduction of weight and space of the subsistence items we use. The reason is obvious. We do not want to leave the impression that we will use dehydrated

foods merely because of the fact that they are in that state. They must always pass the critical test of acceptability applied by the soldier. You probably have heard some of the difficulty we have experienced in the past with dehydrated eggs and dehydrated milk. So, when I say that we are interested in dehydrated orange juice, I mean that we will certainly consider its procurement when and as it will reconstitute to an approximation of the canned orange juice now being supplied to oversea areas.

Question: What percentage of vitamin C in the ration is derived from citrus fruit products?

Answer: Twenty-four percent.

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CONFERENCE HIGHLIGHTS

PROGRAM

OPENING REMARKS

Frank Holland, Chairman, Citrus Committee, Winter Haven Chamber of Commerce, Winter Haven, Fla.

Roy Magruder, Agricultural Research Administration, U. S. Department of Agriculture, Washington, D. C.

MORNING SESSION

Chairman - Ralph Miller, Plymouth Growers Association, Plymouth, Fla.

Recovery of Essence from Fruits
R. K. Eskew, Eastern Regional Research Laboratory, Philadelphia, Pa.

Flavor Fortification of California Frozen Orange Concentrate
E. A. Beavens, Fruit and Vegetable Chemistry Laboratory, Pasadena, Calif.

Gelation and Clarification in Citrus Concentrates
F. W. Wenzel, Citrus Experiment Station, Lake Alfred, Fla.

Adjournment

Group Luncheon

AFTERNOON SESSION

Chairman - W. W. Giddings, Snively Groves, Inc., Winter Haven, Fla.

Processing Heat-Sensitive Liquids by Steam Injection
A. H. Brown, Western Regional Research Laboratory, Albany, Calif.

Storage of Frozen Citrus Concentrate
C. W. DuBois, Minute Maid Corporation, Plymouth, Fla.

Pasteurization Studies
M. K. Veldhuis, U. S. Citrus Products Station, Winter Haven, Fla.

Some Effects of the Freezes of the Past Season in the Rio Grande Valley, W. C. Scott, U. S. Fruit and Vegetable Products Laboratory, Weslaco, Texas

Army Needs in the Citrus Fruit Field
Lt. Col. H. C. Keeney, Quartermaster Corps, U. S. Army, Washington, D. C.

* * *

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SUMMARY

(Note: This summary of the conference was furnished on May 22, 1951, to trade and technical journals serving readers interested in citrus processing.)

Members of the citrus industry and research workers who have contributed to the rapid expansion of citrus processing during recent years, especially in the field of concentrates, took stock of developments at a conference in Winter Haven, Fla., May 9.

The conference, arranged by the U. S. Department of Agriculture in cooperation with advisory groups, brought together many of the nation's leading scientists, growers, and processors to consider jointly the utilization of citrus crops. About 150 persons attended, with all citrus areas represented.

Dr. M. K. Veldhuis, in charge of the U. S. Citrus Products Station, was official host. Representatives of other USDA field stations, State Experiment Stations, industries, and others engaged in citrus processing research participated actively. Dr. Roy Magruder of the Agricultural Research Administration and Harry W. von Loesecke, Bureau of Agricultural and Industrial Chemistry, attended from Washington.

In opening the conference, Frank Holland, Chairman of the Citrus Committee, Winter Haven Chamber of Commerce, attributed the tremendous progress made recently in commercial production of frozen citrus concentrates to the excellent cooperation existing among all groups involved. The conference, he said, reflected this spirit of grower-industry-research cooperation. Holland was introduced by Dr. Ralph Miller of the Plymouth Citrus Growers Association, Plymouth, Fla., who presided at the morning session of the conference. W. W. Giddings of the Polk Packing Company, presided in the afternoon.

C. W. DuBois of the Minute Maid Corporation, Plymouth, Fla., represented processors on the program with a report on the effects of storing concentrates at varying temperatures, ranging from -20 up to 75 degrees F. He said corrosion of cans was related to the storage temperature, following the same trend as clarification. No changes in cloud retention were observed at zero degrees F., and below, but at higher temperatures the rate of cloud loss increased. Flavor deterioration was observed in samples stored for six months or less at 15, 20, and 25 degrees.

Dr. F. W. Wenzel of the Florida Citrus Experiment Station, Lake Alfred, Fla., presented basic data on gelation and clarification obtained in studies conducted in cooperation with the Florida Citrus Commission during the past three seasons. Possible preventative

measures considered include modified processing procedures to eliminate excessive amounts of pectin and pectic enzymes, heat treatment of the juice, the addition of chelating agents and surface active enzyme inhibitors, and storage of the finished concentrates at temperatures not exceeding zero degrees F.

Representatives from regional laboratories and field stations of the Bureau of Agricultural and Industrial Chemistry summarized recent research by the U. S. Department of Agriculture to improve processing operations as well as the quality of concentrates and other citrus products.

In a study to determine desirable temperatures and times of heating for effective pasteurization, Dr. M. K. Veldhuis said the U. S. Citrus Products Station in Winter Haven found that enzyme inactivation was reached in 1.75 seconds when temperatures were 200-210 degrees F., in 13 seconds at 195 degrees, and in 35 seconds at 190 degrees.

A. H. Brown described a direct steam-injection heater employed in high-temperature, short-time processing of fruit and vegetable juices and purees at the Western Regional Research Laboratory, Albany, Calif. Effective pasteurization is obtained with a minimum of flavor alteration, he said.

Dr. E. A. Beavens of the Fruit and Vegetable Chemistry Laboratory, Pasadena, Calif., said pilot-plant studies suggest the possibility of restoring the volatile flavor and aroma lost during the evaporation of juice for orange concentrate by using volatile essence, cold-pressed peel oil or orange puree in place of the cut-back juice. The flavor of concentrates fortified in this manner was found to be stable at zero degrees F., he said.

R. K. Eskew described methods developed for the recovery of apple essence at the Eastern Regional Laboratory in Philadelphia. Similar procedures for the recovery of citrus essence are being studied.

In Texas the first freeze last season damaged the citrus crop seriously and the second reduced the population of citrus groves, greatly handicapping the research program at the Fruit and Vegetable Products Laboratory in Weslaco, W. C. Scott reported. He said, however, that progress has been made in the development of frozen concentrates from red and pink varieties of Texas grapefruit.

Lt. Col. H. C. Keeney of the Quartermaster Corps' Food Service Division, Washington, D. C., closed the program with a discussion of the Army's need for citrus products. He said standard menus for the

armed services contain liberal quantities of orange, grapefruit, and blended juices, as well as frozen orange and tangerine concentrates, and that utilization of these products is expected to increase. He added that concentrated juices are desired which will remain stable at room temperature for periods of six months or longer.

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